



Class 2: Language

David Evans
cs1120 Fall 2011

Question from Class 1

What other things have changed as much as (or more than!) computing power in your lifetime? (Post your guesses/answers as comments on the course blog.)

Only one attempted guess (which I'm not sure I understand)!

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What is Language?

Webster's Dictionary Definition

A ~~systematic~~ means of communicating ~~ideas or feelings~~ by the use of ~~conventionalized signs, sounds, gestures, or marks~~ having ~~understood~~ meanings.

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Linguist's Definition

(Charles Yang)

A description of pairs (S, M) , where S stands for sound, or any kind of **surface forms**, and M stands for **meaning**.

A theory of language must specify the properties of S and M , and how they are related.

A language is:

- a **set of surface forms** (usually strings of characters), and
- a way to map any surface form in the language to a **meaning**

Caveat: computer scientists often use *language* to mean just a set of surface forms.

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What are languages made of?

Primitives (all languages have these)

The simplest surface forms with **meaning**

Means of Combination (all languages have these)

Ways to make new surface forms from ones you already have

Means of Abstraction (all **powerful** languages have these)

Ways to use simple surface forms to represent complicated ones

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Does English have these?

Primitives

Words (?)

"hippopotomonstrosesquipedaliophobia" is not a primitive

Morphemes – smallest units of meaning

e.g., **anti-** ("opposite")

Means of combination

e.g., *Sentence ::= Subject Verb Object*

Precise rules, but not the ones you learned in grammar school

Ending a sentence with a preposition is something up with which we will not put.
Winston Churchill

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Does English have these?

Means of abstraction

Pronouns: **she**, **he**, **it**, **they**, **which**, etc.

Confusing since they don't always mean the same thing, it depends on where they are used.

The **"these"** in the slide title is an abstraction for the three elements of language introduced 2 slides ago.

The **"they"** in the confusing sentence is an abstraction for pronouns.

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Plan

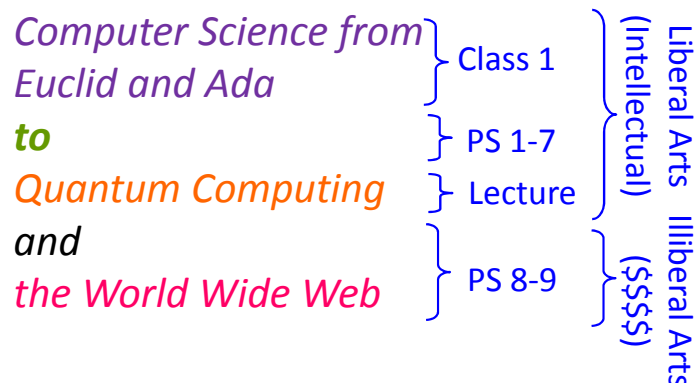
Language, Components of Language

Course Overview and Expectations

How to describe a language

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Course Roadmap (SIS Name)



Course Roadmap (New Name)

Introduction to

Computing:

Explorations in

Language, } Chapters 2-5, 9-11; PS1-9

Logic, and } Chapters 6, 7, 8, 12; PS1-9

Machines } Chapter 6, 12; PS1-9

Also: **XLLM** is better acronym than **FAEQCWWWW**

Why Learning Computer Science is Hard

New way of thinking

- Both abstract and concrete
- Dynamic
- Finite, but quadrillions are common

Everything is connected

- Need to understand lots of new things at once

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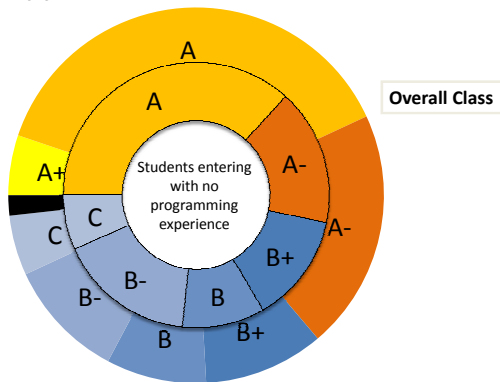
Like Drinking from a Firehose



It may hurt a little bit, and a lot of water will go by you, but you won't go away thirsty!

Don't be overwhelmed! You will do fine.

"Typical" cs1120 Grades



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Background Expected

Language

- Reasonable reading and writing in English
- Understanding of subject, verb and object

Math

- Numbers, add, subtract, multiply, divide
- Exponentiation, [logarithms](#) (we will review)

Logic: and, or, not

Computer Literacy: read email, browse web

If I ever appear to expect anything else, stop me!

What I Expect of You

You are a "Jeffersonian Student"

1. Believe knowledge is powerful
2. Interested in lots of things, ahead of your time
3. Want to use what you learn to do good things
4. Care more about what you learn than grades and degree requirements



<http://soundstrings.wordpress.com>

<http://www.wm.edu/about/history/tjcollege/tjcollegelife/>:

Thomas Jefferson enrolled in the College of William and Mary on March 25, 1760, at the age of sixteen. ... By the time he came to Williamsburg, the young scholar was proficient in the classics and able to read Greek and Latin authors in the original... He was instructed in natural philosophy (**physics, metaphysics, and mathematics**) and moral philosophy (**rhetoric, logic, and ethics**). A keen and diligent student, he displayed an avid curiosity in all fields and, according to family tradition, **he frequently studied fifteen hours a day.**

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Honor

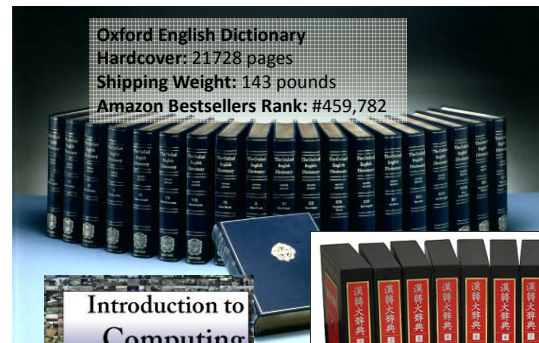
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Questions

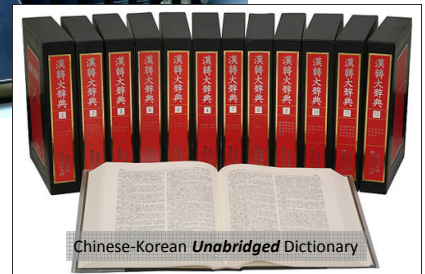
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How should we
describe languages?

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Amazon Bestsellers Rank: #471,120



Chinese-Korean *Unabridged* Dictionary

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How should we describe
precise languages
precisely?

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Requirements

Describe **infinitely** many surface forms with a short description

Listing them all doesn't work: need ways to **generate** the surface forms

Today: formally

Way to map each surface form to exactly one **precise meaning**

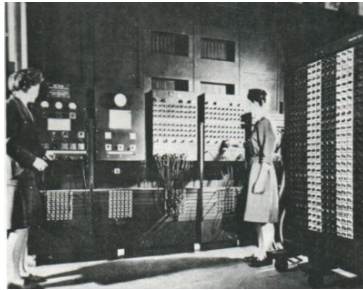
Chapter 3, Monday: informally (using English)
Later (PS7): more formally (defining an interpreter)

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ENIAC: Electronic Numerical Integrator and Computer

Early WWII computer
but **not** the first
(PS4)

Built to calculate
bombing tables



Memory size:

twenty 10 decimal digit accumulators = 664 bits

ENIAC (1946): ½ mm

Apollo Guidance Computer (1969): 1 inch

You: ~10 miles

Directions for Getting 6

1. Choose any regular accumulator (ie. Accumulator #9).
2. Direct the Initiating Pulse to terminal 5i.
3. The initiating pulse is produced by the initiating unit's /o terminal each time the Eniac is started. This terminal is usually, by default, plugged into Program Line 1-1 (described later). Simply connect a program cable from Program Line 1-1 to terminal 5i on this Accumulator.
4. Set the Repeat Switch for Program Control 5 to 6.
5. Set the Operation Switch for Program Control 5 to ADD.
6. Set the Clear-Correct switch to C.
7. Turn on and clear the Eniac.
8. Normally, when the Eniac is first started, a clearing process is begun. If the Eniac had been previously started, or if there are random neons illuminated in the accumulators, the "Initial Clear" button of the Initiating device can be pressed.
9. Press the "Initiating Pulse Switch" that is located on the Initiating device.
10. **Stand back.**

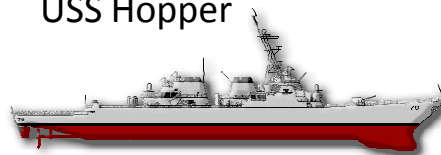


"Nobody believed that I had a running compiler and nobody would touch it. They told me computers could only do arithmetic."

Admiral Grace Hopper (1906-1992)

- Mathematics PhD Yale, 1934
- Entered Navy, 1943
- First to program Mark I (first "large" computer, 51 feet long)
- Wrote first compiler (1952) – program for programming computers and designed FLOW-MATIC programming language
- "Mother" of COBOL (most widely used programming language in 21st century)

USS Hopper



"Dare and Do"



[Guest on David Letterman](#)

Nanostick

How far does light travel in 1 nanosecond?

```
> (define nanosecond (/ 1 (* 1000 1000 1000))) ; 1 billionth of a s
> (define lightspeed 299792458) ; m / s
> (* lightspeed nanosecond)
149896229/500000000
> (exact->inexact (* lightspeed nanosecond))
0.299792458
= just under 1 foot
```

Current machines have at least "2 GHz Pentium 4 CPU"

GHz = GigaHertz = 1 Billion times per second

They must finish a step before light travels **11.5 cm!**

Code written by
humans



Compiler



Code machine can run

Compiler translates
from code in a high-
level language to
machine code

Scheme uses an *interpreter*. An interpreter is like a compiler, except it runs quickly and quietly on small bits of code at a time.

Charge

Problem Set 0: due Sunday, 5:59pm

Help: 3-5pm in Thorton Stacks (Joeseeph and Kristina)

Readings:

by Monday: Chapter 3 of course book

by next Friday:

Chapter 4 of course book

Chapters 1-3 of *The Information*